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RESIDUAL TENSILE PROPERTIES OF MATERIAL FROM C-130 CENTER WING SECTION AFTER SERVICE

by L. R. Kaisand

Final Report

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ABSTRACT

No adverse correlation was found between the residual tensile properties of 7075-T6 material and the associated number of flight hours of the C-130 aircraft from which the specimens were extracted.

OBJECTIVE:

The purpose of this program was to evaluate the material tensile properties existing in C-130 aircraft center wing section structural boxes which were removed from C-130 aircraft and to correlate these properties with aircraft age and utilization.

CONCLUSIONS:

The basic conclusion of this investigation was that the residual tensile properties of the C-130 center wing box material (7075-T6) were not affected by aircraft age and service life.

BACKGROUND:

The Lockheed-Georgia Company is currently engaged in a major wing modification of the C-130 series B and E model aircraft operated by the United States Air Force. This modification consists primarily of replacing the center wing box section with an improved version. The availability of the center wing sections taken from service aircraft provided an unique opportunity to conduct tensile property tests on typical aircraft wing structure that have been in service for various lengths of time.

TECHNICAL APPROACH:

Two test panels were cut from each of 11 C-130 lower surface wing box covers scrapped from the C-130 wing modification program. The particular locations of each panel are shown in Figure 1. The material in this area of the center wing box is 7075-T6. These areas for obtaining the test panels were selected

because they are highly stressed during service. Other locations would have been more desirable such as areas immediately adjacent to the cutouts centered on W.S. 120.5. However, it would have been impossible to get the desired specimen coupons from these areas due to the large amount of supporting structure attached.

Three tensile test coupons were cut from each of the test panels from the locations shown in Figure 2. One specimen was a standard unnotched tensile specimen machined to the SRL-127-3 configuration. The second tensile specimen was hole notched using the existing service holes as the notches and machined to the configuration shown in Figure 3. The third tensile specimen was the same configuration (Figure 4) as the second tensile specimen except the hole-notches were newly drilled non-service holes. All specimens were from the longitudinal grain direction and were identified for the wing box (i.e. C-130 aircraft) from which they were cut.

All the specimens were tested on suitable tensile test machines. For the unnotched specimens F_{tu} and F_{ty} values were recorded. This data is presented in Table I along with the associated number of flight hours and aircraft age for each test value. For the hole notched, service and non-service, specimens F_{ntu} values were recorded and are presented in Tables II and III along with the same service information listed in Table I.

DISCUSSION:

The residual unnotched tensile properties of the C-130 lower wing box covers were not affected by the number of flight hours to which they were subjected.

This fact is illustrated by Figure 5 which is a plot of the tensile data shown in Table I and is presented as a function of service flight hours. If indeed service flight time had had an effect on the tensile properties, the data in Figure 5 would have a downward slope to the right. However, examination of Figure 5 clearly shows this is not the case and any deviation is normal scatter associated with test data.

A statistical analysis of the tensile data presented in Table I was conducted and compared to the Mil-Handbook-5 A & B values for 7075-T6 plate material. This comparison is presented in Table IV and shows the average residual tensile strengths are higher than the Mil-Handbook-5 values for 7075-T6 plate material.

The purpose of testing the hole notched tensile specimens was to determine if any change in the stress concentration factor of the rivet holes had occurred due to service. If the stress concentration factor had changed the notched tensile strength values for the service hole notched specimens would be significantly different than the non-service hole notched specimens and it could be shown statistically that the two sets of data do not belong to the same population. A statistical check on the two data samples, service hole notched tensile strengths versus the non-service hole notched tensile strengths, showed that both data samples belong to the same population.

Figure 6 is a plot of notched tensile strengths for the service and non-service hole specimens as function of aircraft flight hours. This graphical presentation of the data tends to substantiate the statistical conclusion that there was no change in the stress concentration factor of the rivet holes due to aircraft service time.

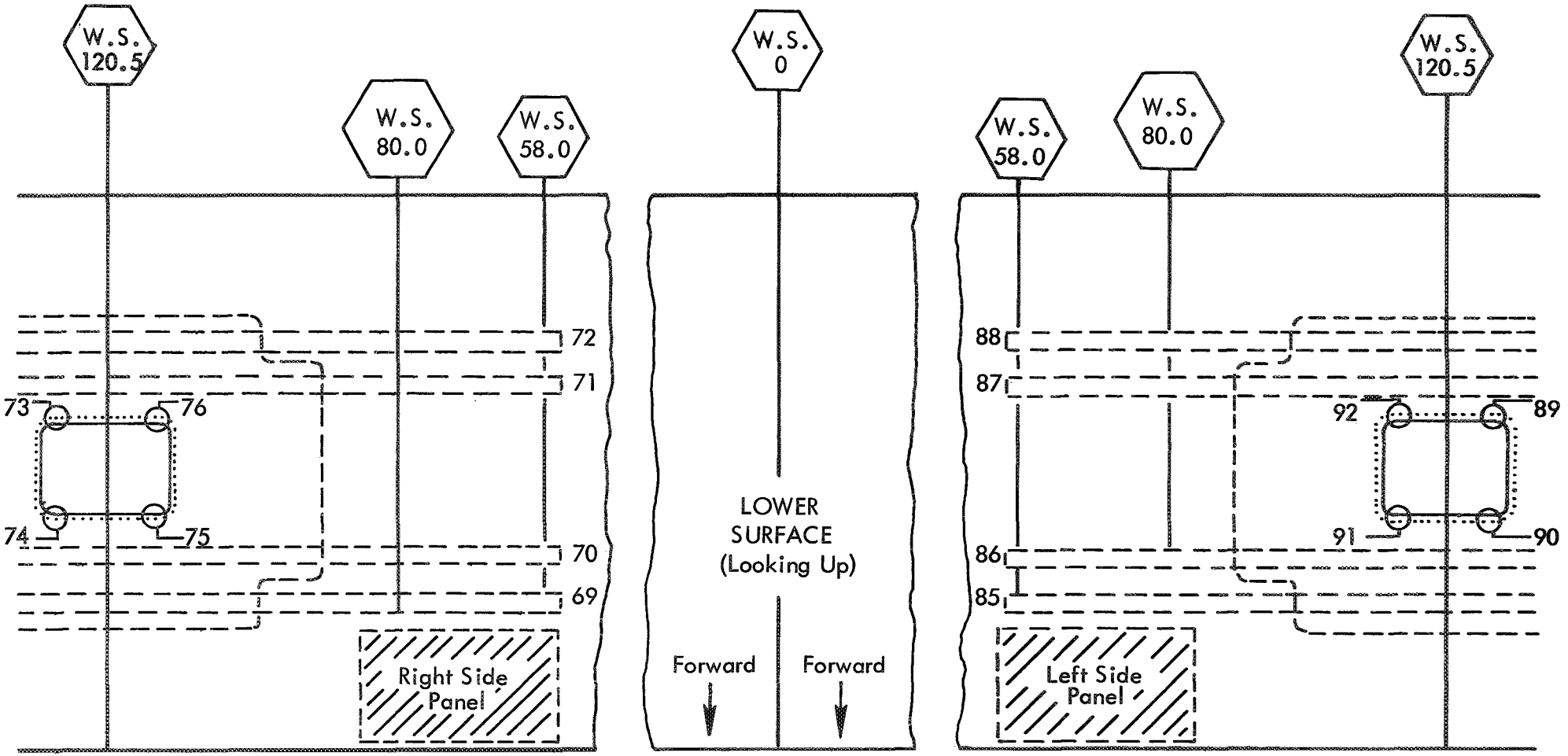


FIGURE 1 PANEL LOCATIONS FROM C-130 CENTER WING BOX

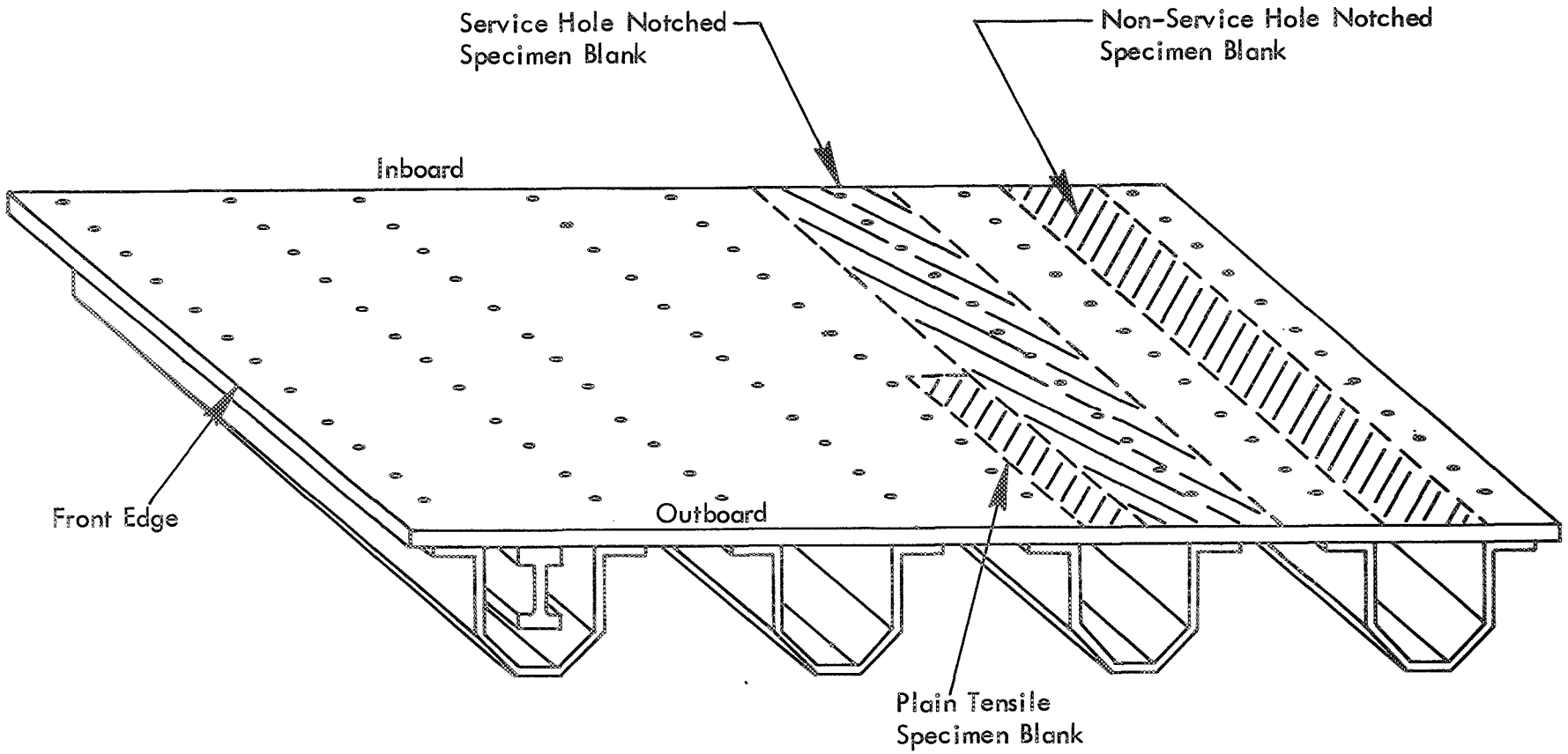
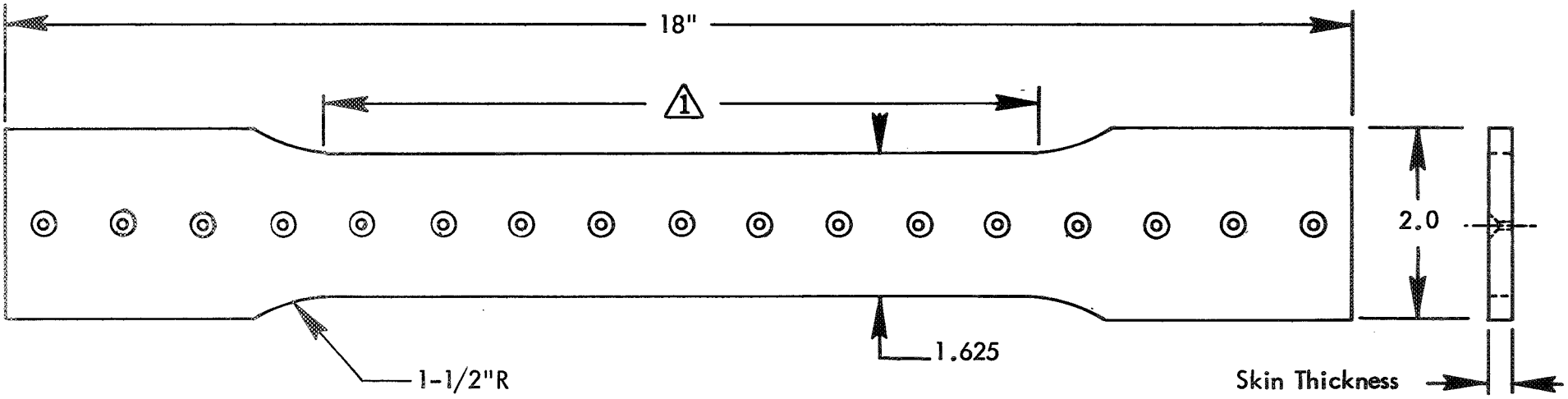
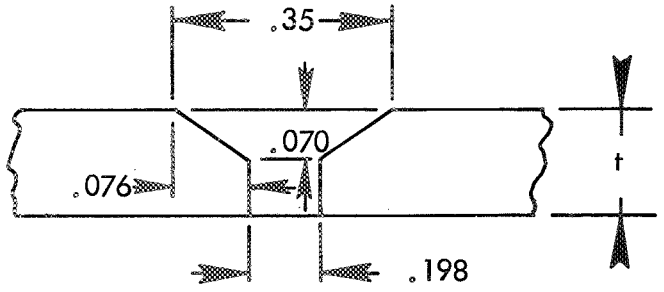


FIGURE 2 SPECIMEN BLANK LOCATIONS ON C-130 CENTER WING BOX PANELS

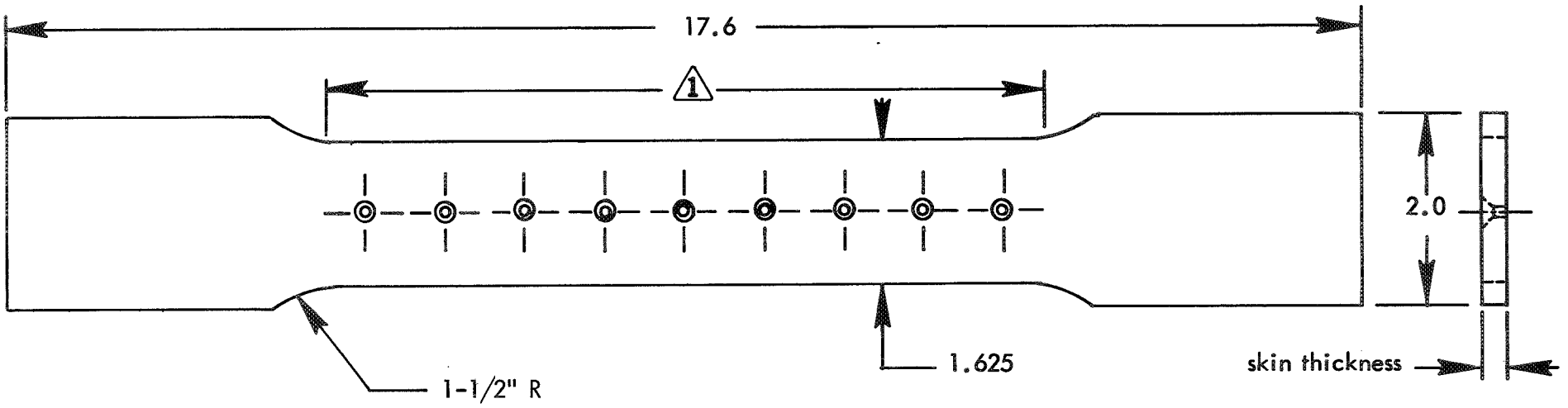


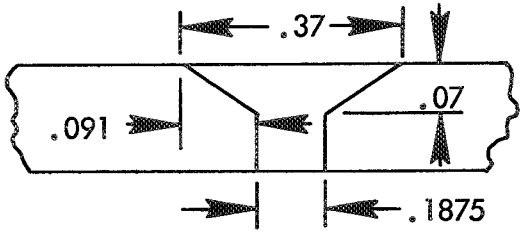


Nominal Dimensions for
Service Rivet Holes

1 Gage length includes 9 rivet holes. Center to center spacing approximately 1". Hole drilled per Gelac Process Specification 0581.

FIGURE 3 SPECIMEN CONFIGURATION FOR SERVICE HOLE NOTCHED TESTS





Nominal Dimensions for
Non Service Rivet Holes

1 Gage length includes 9 rivet holes.
Center to center spacing approximately 1".
Holes drilled per Gelac Process
Specification 0581.

FIGURE 4 NON SERVICE HOLE NOTCHED SPECIMEN CONFIGURATION

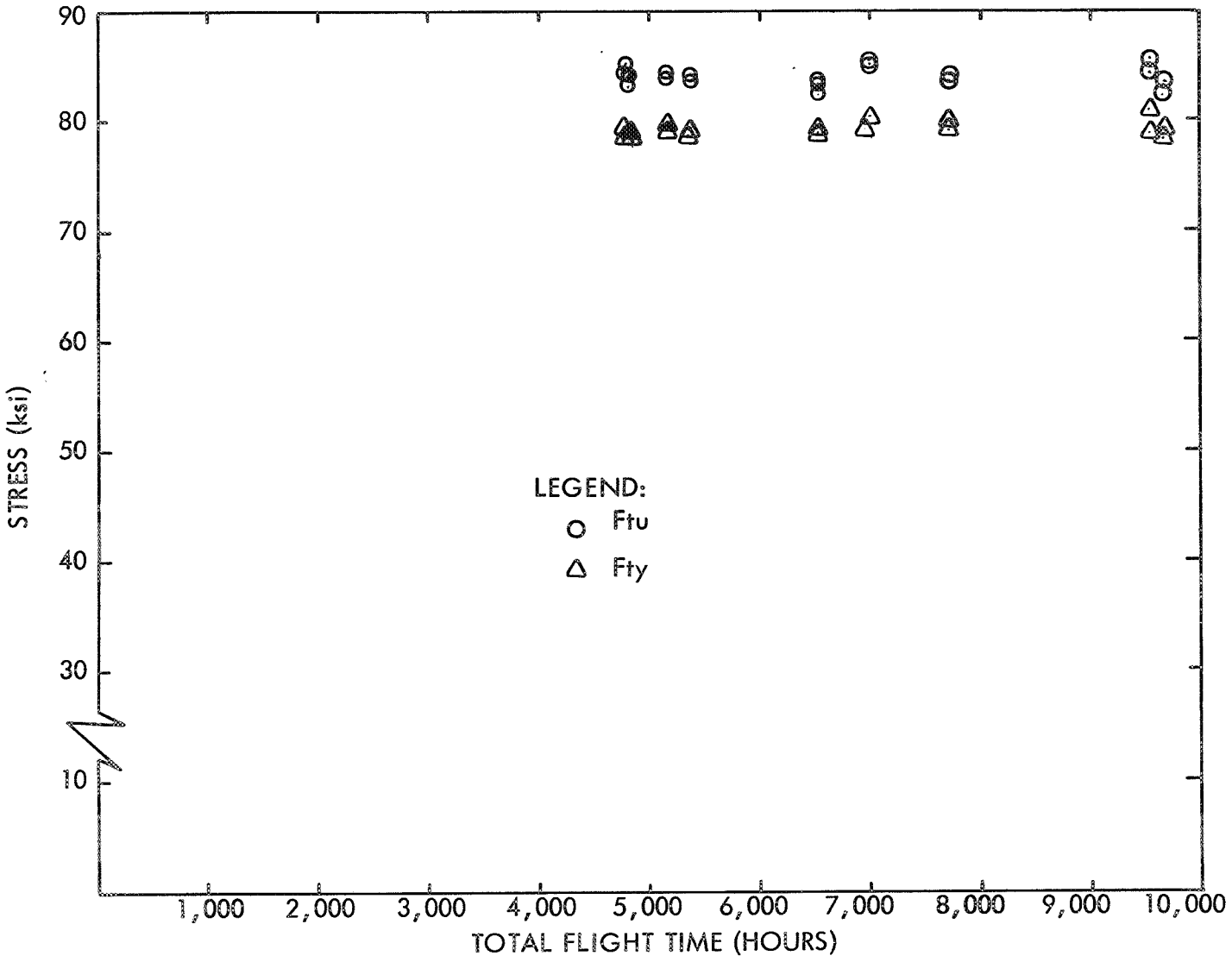


FIGURE 5 STATIC TENSILE PROPERTIES OF C-130 CENTER WING BOXES

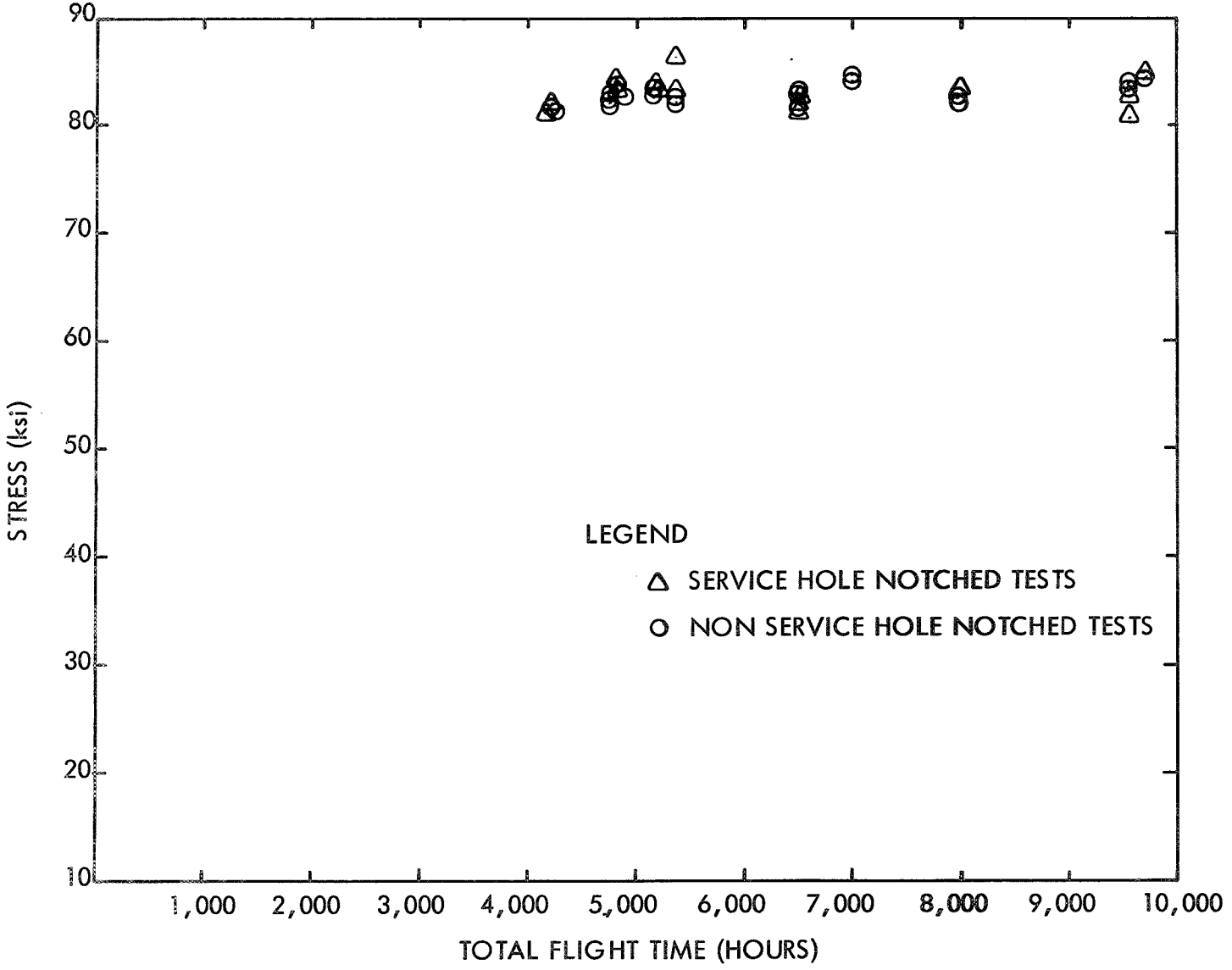


FIGURE 6 NOTCHED TENSILE STRENGTH OF RIVET HOLE NOTCHED SPECIMENS

TABLE I

EFFECT OF FLIGHT HOURS
ON THE TENSILE PROPERTIES (K_t = 1) OF C-130 CENTER
WING BOX COUPONS (7075-T6)

SPEC. NO.	TOTAL FLIGHT HOURS	F_{tu} psi	F_{ty} psi	ELONG. % In 2.0"
63-7867				
L	4223	82,700	76,900	12
R		81,600	77,100	12
61-962				
L	4769	85,000	79,500	12
R		84,300	78,600	12
63-7781				
L	4804	84,100	78,600	12
R		82,700	79,200	11
64-512				
L	5176	84,000	79,500	12
R		84,300	79,600	12
61-971				
L	5350	83,600	79,100	11
R		84,300	79,200	13
62-1841				
L	6520	83,300	79,200	11
R		82,400	79,400	11
62-1863				
L	6521	83,800	79,100	11
R		85,900	84,300	13
63-7835				
L	6995	85,200	80,400	12
R		85,300	79,300	12
62-3492				
L	7726	83,700	79,100	11
R		84,200	80,000	12
63-7837				
L	9538	84,200	78,600	11
R		85,700	80,900	13
63-7846				
L	9683	83,600	79,200	12
R		82,400	78,300	12

TABLE II

EFFECTS OF FLIGHT HOURS ON THE TENSILE PROPERTIES OF SERVICE HOLE NOTCHED C-130 CENTER WING BOX SPECIMENS

SPECIMEN NO.	TOTAL FLIGHT HOURS	F_{ntu} (psi)
63-7867-L	4223	81,100
-R		82,200
61-962-L	4769	82,100
-R		82,200
63-7781-L	4804	83,200
-R		84,100
64-512-L	5176	84,500
-R		84,700
61-971-L	5350	83,200
-R		86,200
62-1841-L	6520	81,500
-R		82,900
62-1863-L	6521	82,900
-R		82,900
63-7835-L	6995	84,200
-R		84,500
62-3492-L	7726	82,300
-R		83,300
63-7837-L	9538	83,100
-R		80,600
63-7846-L	9683	83,900
-R		84,300

TABLE III

EFFECT OF FLIGHT HOURS ON THE TENSILE PROPERTIES OF NON-SERVICE HOLE NOTCHED C-130 CENTER WING BOX SPECIMENS

SPECIMEN NO.	TOTAL FLIGHT HOURS	F_{ntu} (psi)
63-7867-L	4223	81,500
-R		81,200
61-962-L	4769	83,200
-R		82,300
63-7781-L	4804	82,700
-R		83,700
64-512-L	5176	83,100
-R		84,500
61-971-L	5350	82,100
-R		82,300
62-1841-L	6520	81,800
-R		82,500
62-1863-L	6521	83,400
-R		83,200
63-7835-L	6995	84,500
-R		84,100
62-3492-L	7726	82,500
-R		82,000
63-7837-L	9538	82,900
-R		83,800
63-7846-L	9683	83,900
-R		84,000

TABLE IV

COMPARISON OF RESIDUAL TENSILE PROPERTIES
TO MIL-HDBK-5 FOR 7075-T6 PLATE MATERIAL

MATERIAL PROPERTY	AVERAGE RESIDUAL TENSILE PROPERTIES (psi)	STANDARD DEVIATION (psi)	MIL-HDBK-5 A-BASIS (psi)	MIL-HDBK-5 B-BASIS (psi)
F_{tu}	83,900	1100	76,000	78,000
F_{ty}	79,300	1400	68,000	70,000
% E	12		8	